Post-launch performance characterization of the Xenon Feed System on Deep Space One

Authors: Gani B. Ganapathi [♣], Carl Engelbrecht [§]

[♣] Jet Propulsion Laboratory, California Institute of Technology
[§] Primex Aerospace Laboratory, Redmond, WA

ABSTRACT:

The Deep Space One spacecraft is powered by an ion engine for which the working fluid is xenon. This spacecraft is the first of its type to utilize a xenon ion thruster with independently throttled flows to the thruster and its associated cathodes. This increases the functionality *and* complexity of the xenon feed system (XFS) and the associated electronics control system.

In the XFS, xenon is stored in a supercritical state and is independently delivered as a low pressure gas to the engine and cathodes. Each flow is regulated to an accuracy of ± 3% using bang-bang regulators to maintain set pressures in 2 plena which provide the required pressure head to calibrated flow control devices. These regulators are closed-loop controlled using control electronics which use redundant pressure transducers for reference. "Look-up" tables of throttle pressures with temperature correction factors are loaded onto the spacecraft memory.

This paper presents detailed discussions and analyses of the various modes of operation of the XFS. Predicted performance is compared with actual data obtained pre- and post-launch to verify that the XFS is performing as expected. Special emphasis is put on the performance of the flow control devices, bleed-down and pressurization times with error analyses. Since the regulators transition the high pressure xenon to the plena, the transient flow phenomena during opening and closing of the regulator valves is very important and analysis to set optimal open and close times are also presented.